from mixing products are eliminated. The architecture allows for a single synthesizer promoting lower cost and a smaller number of parts.

It is still a further object of the invention to provide a non-harmonic frequency plan to enable a VCO to run at a lower frequency and thereby implement larger value filters and mixers, for example, which are less sensitive to board parisitics and are further easier to tune with less beads, shielding and bypassing.

With these and other objects, advantages and features of the invention that may become hereinafter apparent, the nature of the invention may be more clearly understood by reference to the following detailed description of the invention, the appended claims, and several drawings herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein like numerals describe like components throughout the several views:

FIG. 1 is a prior art schematic representing a signal processing system implemented to attenuate frequency pulling; and

FIG. 2 is a schematic representing a high level integration of the major components in accordance with the present invention.

## DETAILED DESCRIPTION OF THE DRAWINGS

The implementation of the present invention encompasses a number of applications in which radio frequency signal modulation is required. Specifically, the invention is advantageously implemented to replace complex filter architectures including synthesizers and oscillators which are needed to eliminate oscillator frequency pulling.

FIG. 2 represents an integrated scheme of the present invention. Preferably, a signal from signal source **20** is modified via frequency divider **22** which directs the modified signal to phase detector **24**. Phase detector **24** compares the signal and directs it to LPF **26** where the frequency is conditioned and further directed to VCO **28**. VCO **28** is a voltage controlled oscillator and produces a frequency equal to frequency source **20** modified by a factor. The output frequency from VCO **28** is directed to mixer **30** and as well to frequency divider **32**. Frequency divider **32** directs the output frequency to frequency divider **34** from where it is directed into phase detector **24**. Further, on the output side of mixer **30**, the output frequency is directed to pretransmission filter **36**. Finally the output frequency is directed from pre-transmission filter **36** into amplifier **38**. The resulting output frequency is 1.5 times VCO **28** frequency and is directed to antenna **40** for transmission.

One of the significant aspects of the present invention depicted in the embodiment of FIG. 2 includes the elimination of dual synthesized local oscillators. This is implemented to reduce frequency pulling. Specifically the architecture utilizes a unique circuit in which multipliers are coupled to multiply VCO **28** output frequency to yield a frequency output exactly 1.5 times higher than VCO **28** output frequency to ensure a non-harmonic relationship therebetween.

Accordingly, the overall system of the invention allows the output frequency of the transmitter's power amplifier to be non-harmonically related to the VCO. Typically, large signal power will couple back to the VCO and injection lock the VCO and skew the oscillation frequency (frequency pulling). This phenomenon can occur with radiated or conducted coupling due to proximity of the power amplifier to the VCO and can also occur due to impedance variations seen by the VCO when the Power Amplifier is AM modulated. Impedance variations at the VCO output usually occur during the on/off switching of the Power Amplifier during AM Modulation and can be significantly large if the Power Amplifier is harmonically related to the VCO. The method, in accordance with the present invention, reduces the likelihood of frequency pulling due to injection locking or impedance variations because of the fact that the output frequency is non-harmonically related. This method may be employed whenever frequency pulling is of concern (whether the system is a transmitter or only a modulator) and significantly reduces the component costs by utilizing only one synthesizer and a low Q filter (since all of the undesired spurious due to the upconverter lie on top of the desired signal and is therefore non-degenerating of performance).

Although the present invention has been shown and described with respect to preferred embodiments, various changes and modifications could be made that are obvious to a person skilled in the art to which the invention pertains even if not shown or specifically described herein, are deemed to lie within the spirit and scope of the invention and the following claims.

What is claimed is:

1. Apparatus for reducing frequency pulling of an output VCO involving AM modulation wherein the output frequency is structured to be larger than a synthesizer VCO frequency by a factor greater than unity to maintain a non-harmonic relation between the synthesizer and the output VCO, the apparatus comprising:
   - a source for signals;
   - the synthesizer for synthesizing said signals being in communication with a first frequency divider;
   - a second frequency divider connected to the output VCO;
   - a third frequency divider connected to said second frequency divider and further connected to said synthesizer;
   - a mixer connected to the transmission side of the output VCO and further connected to the transmission side of said second frequency divider;
   - a pretransmission filter connected to said mixer on the transmission side; and
   - an amplifier connected to the pretransmission filter and further connected to a transmitter;
   - the output frequency at said amplifier being non-harmonically related to the synthesizer VCO to thereby minimize frequency pulling during the AM modulation of the output VCO.

2. The apparatus of claim 1, wherein said mixer is structured to accept about 100% of the frequency from the output VCO and further accept a frequency input equal to about 50% of the output VCO.

3. The apparatus of claim 1, wherein said third frequency divider is structured to distribute

$$\frac{1}{N} \times 50\%$$

of the frequency from the output VCO to the phase detector.

4. A frequency pulling reduction architecture implemented in an AM modulation process wherein spurious responses resulting from mixing products are eliminated, the architecture comprising:
   - a frequency transmitter scheme having a 3/2 frequency output;

a frequency synthesizer; and

said frequency output being developed from a VCO for both said transmitter and being non-harmonically related to a VCO frequency of said synthesizer.

**5**. The architecture according to claim **4**, wherein said transmitter scheme includes a frequency source and a frequency divider.

**6**. The architecture according to claim **4**, wherein said frequency synthesizer is coupled to a plurality of conditioned frequencies at the input side and a low pass filter at the output side.

**7**. The architecture according to claim **4**, wherein said 3/2 frequency output comprises conditioned frequencies from a frequency source and said VCO.

**8**. A method of reducing frequency pulling in an AM modulation process wherein spurious responses resulting from mixing devices are eliminated, the method comprising the steps of:

generating a VCO output frequency equal to a value obtained from a source frequency conditioned by a plurality of frequency dividers and phase detectors;

introducing said VCO output into a mixer;

adding ½ of said VCO output into said mixer via one of said frequency dividers;



introducing ½ of said VCO output into said synthesizer via one of said plurality of frequency dividers; and

producing a frequency output equal to 1.5 times greater than said VCO output frequency at an output amplifier.

**9**. The method according to claim **8**, wherein said step of introducing ½ of said VCO output into said synthesizer includes the step of apportioning ½ of said VCO frequency using a ½ frequency divider to generate an output frequency equal to ½ the VCO frequency ($F_{VCO}$).

**10**. The method according to claim **9**, wherein said step of apportioning includes the step of directing ½ of the $F_{VCO}$ into two opposite directions wherein one of the opposite directions feeds into a mixer.

**11**. The method according to claim **10**, wherein said step of directing includes introducing ½ of the $F_{VCO}$ into a divider which ultimately feeds into the phase detector.

**12**. The method according to claim **8**, wherein said step of producing a frequency output includes mixing output frequencies of $F_{VCO}$ and ½ $F_{VCO}$ in a mixer to generate a frequency output equal to 3/2 $F_{VCO}$.

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